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Practitioner's Docket No. 98208

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Box Patent Application  
Assistant Commissioner for Patents  
Washington, D.C. 20231

NEW APPLICATION TRANSMITTAL

Transmitted herewith for filing is the patent application of  
Inventor(s): Melvin J. Laurila, Claus C. Bachmann, Albert P. Klein

WARNING: Patent must be applied for in the name(s) of all of the actual inventor(s). 37 CFR 1.41(a) and 1.53(b).

For (title):

X-RAY FLUORESCENCE ELEMENTAL ANALYZER

CERTIFICATION UNDER 37 C.F.R. 1.10\*

(Express Mail label number is mandatory.)

(Express Mail certification is optional.)

I hereby certify that this New Application Transmittal and the documents referred to as attached therein are being deposited with the United States Postal Service on this date 9/17/98, in an envelope as "Express Mail Post Office to Addressee," mailing Label Number EL059589940US, addressed to the: Assistant Commissioner for Patents, Washington, D.C. 20231.

Charles F. Meroni, Jr.

(type or print name of person mailing paper)

Charles F. Meroni, Jr.

Signature of person mailing paper

WARNING: Certificate of mailing (first class) or facsimile transmission procedures of 37 C.F.R. 1.8 cannot be used to obtain a date of mailing or transmission for this correspondence.

\*WARNING: Each paper or fee filed by "Express Mail" must have the number of the "Express Mail" mailing label placed thereon prior to mailing. 37 C.F.R. 1.10(b).

"Since the filing of correspondence under § 1.10 without the Express Mail mailing label thereon is an oversight that can be avoided by the exercise of reasonable care, requests for waiver of this requirement will **not** be granted on petition." Notice of Oct. 24, 1996, 60 Fed. Reg. 56,439, at 56,442.

(Application Transmittal [4-1]—page 1 of 9)

## 1. Type of Application

This new application is for a(n)

(check one applicable item below)

- ☒ Original (nonprovisional)  
☐ Design  
☐ Plant

**WARNING:** Do not use this transmittal for a completion in the U.S. of an International Application under 35 U.S.C. 371(c)(4), unless the International Application is being filed as a divisional, continuation or continuation-in-part application.

**WARNING:** Do not use this transmittal for the filing of a provisional application.

**NOTE:** If one of the following 3 items apply, then complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF A PRIOR U.S. APPLICATION CLAIMED and a NOTIFICATION IN PARENT APPLICATION OF THE FILING OF THIS CONTINUATION APPLICATION.

- ☐ Divisional.  
☐ Continuation.  
☐ Continuation-in-part (C-I-P).

## 2. Benefit of Prior U.S. Application(s) (35 U.S.C. 119(e), 120, or 121)

**NOTE:** If the new application being transmitted is a divisional, continuation or a continuation-in-part of a parent case, or where the parent case is an International Application which designated the U.S., or benefit of a prior provisional application is claimed, then check the following item and complete and attach ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

**WARNING:** If an application claims the benefit of the filing date of an earlier filed application under 35 U.S.C. 120, 121 or 365(c), the 20-year term of that application will be based upon the filing date of the earliest U.S. application that the application makes reference to under 35 U.S.C. 120, 121 or 365(c). (35 U.S.C. 154(a)(2) does not take into account, for the determination of the patent term, any application on which priority is claimed under 35 U.S.C. 119, 365(a) or 365(b).) For a c-i-p application, applicant should review whether any claim in the patent that will issue is supported by an earlier application and, if not, the applicant should consider canceling the reference to the earlier filed application. The term of a patent is not based on a claim-by-claim approach. See Notice of April 14, 1995, 60 Fed. Reg. 20,195, at 20,205.

**WARNING:** When the last day of pendency of a provisional application falls on a Saturday, Sunday, or Federal holiday within the District of Columbia, any nonprovisional application claiming benefit of the provisional application must be filed prior to the Saturday, Sunday, or Federal holiday within the District of Columbia. See 37 C.F.R. § 1.78(a)(3).

- ☐ The new application being transmitted claims the benefit of prior U.S. application(s). Enclosed are ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

## 3. Papers Enclosed That Are Required for Filing Date under 37 C.F.R. 1.53(b) (Regular) or 37 C.F.R. 1.153 (Design) Application

10 Pages of specification  
3 Pages of claims  
1 Pages of Abstract  
4 Sheets of drawing

- ☐ formal  
☒ informal

**WARNING:** *DO NOT* submit original drawings. A high quality copy of the drawings should be supplied when filing a patent application. The drawings that are submitted to the Office must be on strong, white, smooth, and non-shiny paper and meet the standards according to § 1.84. If corrections to the drawings are necessary, they should be made to the original drawing and a high-quality copy of the corrected original drawing then submitted to the Office. Only one copy is required or desired. Comments on proposed new 37 CFR 1.84. Notice of March 9, 1988 (1990 O.G. 57-62).

**NOTE:** "Identifying indicia, if provided, should include the application number or the title of the invention, inventor's name, docket number (if any), and the name and telephone number of a person to call if the Office is unable to match the drawings to the proper application. This information should be placed on the back of each sheet of drawing a minimum distance of 1.5 cm. (5/8 inch) down from the top of the page." 37 C.F.R. 1.84(c).

(complete the following, if applicable)

- ☐ The enclosed drawing(s) are photograph(s), and there is also attached a "PETITION TO ACCEPT PHOTOGRAPH(S) AS DRAWING(S)." 37 C.F.R. 1.84(b).

**4. Additional papers enclosed**

- ☐ Preliminary Amendment  
☒ Information Disclosure Statement (37 C.F.R. 1.98)  
☒ Form PTO-1449 (PTO/SB/08A and 08B)  
☐ Citations  
☐ Declaration of Biological Deposit  
☐ Submission of "Sequence Listing," computer readable copy and/or amendment pertaining thereto for biotechnology invention containing nucleotide and/or amino acid sequence.  
☐ Authorization of Attorney(s) to Accept and Follow Instructions from Representative  
☐ Special Comments  
☐ Other

**5. Declaration or oath**

- ☒ Enclosed  
Executed by

(check all applicable boxes)

- ☒ inventor(s).  
☐ legal representative of inventor(s).  
37 CFR 1.42 or 1.43.  
☐ joint inventor or person showing a proprietary interest on behalf of inventor who refused to sign or cannot be reached.  
☐ This is the petition required by 37 CFR 1.47 and the statement required by 37 CFR 1.47 is also attached. See item 13 below for fee.  
☐ Not Enclosed.

**WARNING:** Where the filing is a completion in the U.S. of an International Application, but where a declaration is not available, or where the completion of the U.S. application contains subject matter in addition to the International Application, the application may be treated as a continuation or continuation-in-part, as the case may be, utilizing ADDED PAGE FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION CLAIMED.

- ☐ Application is made by a person authorized under 37 C.F.R. 1.41(c) on behalf of all the above named inventor(s).

*(The declaration or oath, along with the surcharge required by 37 CFR 1.16(e) can be filed subsequently).*

NOTE: It is important that all the correct inventor(s) are named for filing under 37 CFR 1.41(c) and 1.53(b).

- ☐ Showing that the filing is authorized.  
(not required unless called into question. 37 CFR 1.41(d))

## 6. Inventorship Statement

**WARNING:** If the named inventors are each not the inventors of all the claims an explanation, including the ownership of the various claims at the time the last claimed invention was made, should be submitted.

The inventorship for all the claims in this application are:

- ☒ The same.

or

- ☐ Not the same. An explanation, including the ownership of the various claims at the time the last claimed invention was made,  
☐ is submitted.  
☐ will be submitted.

## 7. Language

NOTE: An application including a signed oath or declaration may be filed in a language other than English. A verified English translation of the non-English language application and the processing fee of \$130.00 required by 37 CFR 1.17(k) is required to be filed with the application, or within such time as may be set by the Office. 37 CFR 1.52(d).

NOTE: A non-English oath or declaration in the form provided or approved by the PTO need not be translated. 37 CFR 1.69(b).

- ☒ English  
☐ Non-English  
☐ The attached translation is a verified translation. 37 C.F.R. 1.52(d).

## 8. Assignment

- ☒ An assignment of the invention to Process Control, Inc.  
A Delaware Corporation

- ☒ is attached. A separate ☒ "COVER SHEET FOR ASSIGNMENT (DOCUMENT) ACCOMPANYING NEW PATENT APPLICATION" or ☐ FORM PTO 1595 is also attached.  
☐ will follow.

NOTE: "If an assignment is submitted with a new application, send two separate letters—one for the application and one for the assignment." Notice of May 4, 1990 (1114 O.G. 77-78).

**WARNING:** A newly executed "CERTIFICATE UNDER 37 CFR 3.73(b)" must be filed when a continuation-in-part application is filed by an assignee. Notice of April 30, 1993, 1150 O.G. 62-64.

## 9. Certified Copy

Certified copy(ies) of application(s)

Country	Appln. No.	Filed
Country	Appln. No.	Filed
Country	Appln. No.	Filed

from which priority is claimed

- ☐ is (are) attached.  
☐ will follow.

NOTE: The foreign application forming the basis for the claim for priority must be referred to in the oath or declaration. 37 CFR 1.55(a) and 1.63.

NOTE: This item is for any foreign priority for which the application being filed directly relates. If any parent U.S. application or International Application from which this application claims benefit under 35 U.S.C. 120 is itself entitled to priority from a prior foreign application, then complete item 18 on the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED.

## 10. Fee Calculation (37 C.F.R. 1.16)

- A. ☐ Regular application

CLAIMS AS FILED			
Number filed	Number Extra	Rate	Basic Fee 37 C.F.R. 1.16(a) \$790.00
Total Claims (37 CFR 1.16(c)) 15 - 20 =	×	\$ 22.00	
Independent Claims (37 CFR 1.16(b)) / - 3 =	×	\$ 82.00	
Multiple dependent claim(s), if any (37 CFR 1.16(d))	+	\$270.00	

- ☐ Amendment cancelling extra claims is enclosed.  
☐ Amendment deleting multiple-dependencies is enclosed.  
☐ Fee for extra claims is not being paid at this time.

NOTE: If the fees for extra claims are not paid on filing they must be paid or the claims cancelled by amendment, prior to the expiration of the time period set for response by the Patent and Trademark Office in any notice of fee deficiency. 37 CFR 1.16(d).

Filing Fee Calculation

\$ 790.00

- B. ☐ Design application  
(\$330.00—37 CFR 1.16(f))

Filing Fee Calculation \$ \_\_\_\_\_

- C. ☐ Plant application  
(\$540.00—37 CFR 1.16(g))

Filing fee calculation \$ \_\_\_\_\_

**11. Small Entity Statement(s)**

- ☒ Verified Statement(s) that this is a filing by a small entity under 37 CFR 1.9 and 1.27 is (are) attached.

**WARNING:** "Status as a small entity in one application or patent does not affect any other application or patent, including applications or patents which are directly or indirectly dependent upon the application or patent in which the status has been established. A nonprovisional application claiming benefit under 35 U.S.C. 119(e), 120, 121 or 365(c) of a prior application may rely on a verified statement filed in the prior application if the nonprovisional application includes a reference to a verified statement in the prior application or includes a copy of the verified statement filed in the prior application if status as a small entity is still proper and desired." 37 C.F.R. § 1.28(a).

(complete the following, if applicable)

- ☐ Status as a small entity was claimed in prior application  
\_\_\_\_\_ / \_\_\_\_\_, filed on \_\_\_\_\_, from which benefit  
is being claimed for this application under:

35 U.S.C. ☐ 119(e),  
☐ 120,  
☐ 121,  
☐ 365(c),

and which status as a small entity is still proper and desired.

- ☒ A copy of the verified statement in the prior application is included.

Filing Fee Calculation (50% of A, B or C above)

\$ 395.00

**NOTE:** Any excess of the full fee paid will be refunded if a verified statement and a refund request are filed within 2 months of the date of timely payment of a full fee. The two-month period is not extendable under § 1.136. 37 CFR 1.28(a).

**12. Request for International-Type Search (37 C.F.R. 1.104(d))**

(complete, if applicable)

- ☐ Please prepare an international-type search report for this application at the time when national examination on the merits takes place.

13. Fee Payment Being Made at This Time

☐ Not Enclosed

☐ No filing fee is to be paid at this time.

*(This and the surcharge required by 37 C.F.R. 1.16(e) can be paid subsequently.)*

☒ Enclosed

☒ Filing fee

\$ 395.00

☒ Recording assignment

(\$40.00; 37 C.F.R. 1.21(h))

(See attached "COVER SHEET FOR  
ASSIGNMENT ACCOMPANYING NEW  
APPLICATION".)

\$ 40.00

☐ Petition fee for filing by other than all the  
inventors or person on behalf of the inventor  
where inventor refused to sign or cannot be  
reached

(\$130.00; 37 C.F.R. 1.47 and 1.17(h))

\$ \_\_\_\_\_

☐ For processing an application with a  
specification in  
a non-English language

(\$130.00; 37 C.F.R. 1.52(d) and 1.17(k))

\$ \_\_\_\_\_

☐ Processing and retention fee

(\$130.00; 37 C.F.R. 1.53(d) and 1.21(l))

\$ \_\_\_\_\_

☐ Fee for international-type search report

(\$40.00; 37 C.F.R. 1.21(e))

\$ \_\_\_\_\_

NOTE: 37 CFR 1.21(f) establishes a fee for processing and retaining any application that is abandoned for failing to complete the application pursuant to 37 CFR 1.53(d) and this, as well as the changes to 37 CFR 1.53 and 1.78, indicate that in order to obtain the benefit of a prior U.S. application, either the basic filing fee must be paid, or the processing and retention fee of § 1.21(f) must be paid, within 1 year from notification under § 53(d).

Total fees enclosed

\$ 435.00

14. Method of Payment of Fees

☒ Check in the amount of \$ 435.00

☐ Charge Account No. \_\_\_\_\_ in the amount of  
\$ \_\_\_\_\_.

A duplicate of this transmittal is attached.

NOTE: Fees should be itemized in such a manner that it is clear for which purpose the fees are paid. 37 CFR 1.22(b).

09156078 09199  
B62T60 82095T60

## 15. Authorization to Charge Additional Fees

**WARNING:** If no fees are to be paid on filing, the following items should not be completed.

**WARNING:** Accurately count claims, especially multiple dependent claims, to avoid unexpected high charges, if extra claim charges are authorized.

- ☐ The Commissioner is hereby authorized to charge the following additional fees by this paper and during the entire pendency of this application to Account No. \_\_\_\_\_:

- ☐ 37 C.F.R. 1.16(a), (f) or (g) (filing fees)  
☐ 37 C.F.R. 1.16(b), (c) and (d) (presentation of extra claims)

**NOTE:** Because additional fees for excess or multiple dependent claims not paid on filing or on later presentation must only be paid or these claims cancelled by amendment prior to the expiration of the time period set for response by the PTO in any notice of fee deficiency (37 CFR 1.16(d)), it might be best not to authorize the PTO to charge additional claim fees, except possibly when dealing with amendments after final action.

- ☐ 37 C.F.R. 1.16(e) (surcharge for filing the basic filing fee and/or declaration on a date later than the filing date of the application)  
☐ 37 C.F.R. 1.17 (application processing fees)

**WARNING:** While 37 CFR 1.17(a), (b), (c) and (d) deal with extensions of time under § 1.136(a), this authorization should be made only with the knowledge that: "Submission of the appropriate extension fee under 37 C.F.R. 1.136(a) is to no avail unless a request or petition for extension is filed." (Emphasis added). Notice of November 5, 1985 (1060 O.G. 27).

- ☐ 37 C.F.R. 1.18 (issue fee at or before mailing of Notice of Allowance, pursuant to 37 C.F.R. 1.311(b))

**NOTE:** Where an authorization to charge the issue fee to a deposit account has been filed before the mailing of a Notice of Allowance, the issue fee will be automatically charged to the deposit account at the time of mailing the notice of allowance. 37 CFR 1.311(b).

**NOTE:** 37 CFR 1.28(b) requires "Notification of any change in status resulting in loss of entitlement to small entity status must be filed in the application . . . prior to paying, or at the time of paying, . . . issue fee." From the wording of 37 CFR 1.28(b), (a) notification of change of status must be made even if the fee is paid as "other than a small entity" and (b) no notification is required if the change is to another small entity.

## 16. Instructions as to Overpayment

- ☐ Credit Account No. \_\_\_\_\_  
☐ Refund

Reg. No. 20,109

Tel. No. (847) 304-1500

Customer No.

Charles F. Meroni, Jr.  
SIGNATURE OF PRACTITIONER

Charles F. Meroni, Jr.  
(type or print name of attorney)

P.O. Box 309  
P.O. Address

Barrington, IL 60011



☐ Incorporation by reference of added pages

*(check the following item if the application in this transmittal claims the benefit of prior U.S. application(s) (including an international application entering the U.S. stage as a continuation, divisional or C-I-P application) and complete and attach the ADDED PAGES FOR NEW APPLICATION TRANSMITTAL WHERE BENEFIT OF PRIOR U.S. APPLICATION(S) CLAIMED)*

- ☐ Plus Added Pages for New Application Transmittal Where Benefit of Prior U.S. Application(s) Claimed

Number of pages added \_\_\_\_\_

- ☒ Plus Added Pages for Papers Referred to in Item 4 Above

Number of pages added \_\_\_\_\_

- ☐ Plus "Assignment Cover Letter Accompanying New Application"

Number of pages added \_\_\_\_\_

☐ Statement Where No Further Pages Added

*(if no further pages form a part of this Transmittal, then end this Transmittal with this page and check the following item)*

- ☒ This transmittal ends with this page.

09156078 091798  
862760 82095160

Practitioner's Docket No. 98208

**PATENT**

☒ Applicant ☐ Patentee \_\_\_\_\_

☐ Application No. ☐ Patent No. \_\_\_\_\_

☐ Filed on ☐ Issued on \_\_\_\_\_

Title: X-RAY FLUORESCENCE ELEMENTAL ANALYZER

**VERIFIED STATEMENT CLAIMING SMALL ENTITY STATUS  
(37 CFR 1.9(f) and 1.27(b))—INDEPENDENT INVENTOR**

As a below named inventor, I hereby declare that I qualify as an independent inventor, as defined in 37 CFR 1.9(c), for purposes of paying reduced fees to the United States Patent and Trademark Office under Sections 41(a) and (b) of Title 35, United States Code, to the Patent and Trademark Office, with regard to the invention described in

☒ the specification filed herewith, with title as listed above.

☐ the application identified above.

☐ the patent identified above.

I have not assigned, granted, conveyed or licensed, and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who would not qualify as an independent inventor under 37 CFR 1.9(c), if that person had made the invention, or to any concern that would not qualify as a small business concern under 37 CFR 1.9(d), or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

☒ No such person, concern, or organization exists.

☐ Each such person, concern or organization is listed below.\*

\*NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

FULL NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

FULL NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

FULL NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

Variable	Mean	SD	Min	Max
Age	34.5	10.2	22	55
Gender	0.5	0.5	0	1
Marital Status	0.6	0.5	0	1
Education	12.5	1.5	9	16
Income	1500	500	500	3000
Health Status	0.7	0.4	0	1
Stress Level	3.5	1.2	1	5
Life Satisfaction	4.2	1.0	1	5
Work-Life Balance	3.8	1.1	1	5
Family Support	4.5	0.8	1	5
Community Involvement	2.5	0.9	1	4
Personal Growth	3.2	1.0	1	5
Overall Well-being	3.9	1.1	1	5

Melvin J. Laurila

Name of inventor  
Melvin J. Kuntz  
Signature of inventor

Date 9/17/98

Name of inventor

Date \_\_\_\_\_

Name of inventor

Date \_\_\_\_\_

I acknowledge the duty to file, in this application or patent, nomination of any change in status resulting in fees or entitlement to small entity status prior to paying, or at the time of paying, the cost of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(h))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

Melvin J. Laurila  
Name of inventor

\_\_\_\_\_  
Signature of inventor Date \_\_\_\_\_

Claus C. Bachmann  
Name of inventor

Claus Bachmann  
Signature of inventor Date 98.9.16

Albert P. Klein  
Name of inventor

Albert P. Klein  
Signature of inventor Date 98.9.16

(Small Entity—Independent Inventor [7-1]—page 2 of 2)

09156078.091798

**PATENT**

Our Case No. 98208

**APPLICATION FOR LETTERS PATENT OF THE  
UNITED STATES OF AMERICA BY**

Melvin J. Laurila

24674 W. August Lane

Lake Zurich, IL 60047

U.S.A.

Claus C. Bachmann

41 Silcherst

D-75323 Bad Wildbad

GERMANY

Albert P. Klein

8 Ahornweg

D-72226 Simmersfeld

GERMANY

FOR:

**X-RAY FLUORESCENCE ELEMENTAL ANALYZER**

09156078-091798

**SPECIFICATION**

TO WHOM IT MAY CONCERN:

BE IT KNOWN that MELVIN J LAURILA is a citizen of the United States and is a resident of Lake Zurich, IL, U.S.A., CLAUS C. BACHMANN is a citizen of Germany and is a resident of Bad Wildbad, ALBERT P. KLEIN is a citizen of Germany and is a resident of Simmersfeld. and have invented new and useful improvements in an

**X-RAY FLUORESCENCE ELEMENTAL ANALYZER**

and do hereby declare that the following is a full, clear and exact description, reference being had to the accompanying drawings and to the numerals of reference marked thereon, which form a part of this specification.

091503-04798  
BACHMANN

## X- RAY FLUORESCENCE ELEMENTAL ANALYZER

### BACKGROUND AND SUMMARY OF THE INVENTION

This invention relates to a method and apparatus for analyzing the composition of coal, mineral ores and other products using energy dispersive X-ray fluorescence (XRF) spectroscopy. In the preparation and utilization of coal as a fuel, it is necessary to quantify the chemical and physical characteristics of the coal or ore. Coal purchases or trades are based on one or more of the following physical or chemical characteristics which are measured during the preparation and prior to the use of the coal feedstock:

- Ash content
- Moisture content
- Calorific value content
- Sulfur content
- Elemental analysis

In order to determine these characteristics the coal must be sampled, the sample prepared and then analyzed by standard laboratory procedures as set forth by organizations such as the American Society for Testing and Materials (ASTM) and/or the International Organization of Standardization (ISO). This is a costly and time consuming process requiring anywhere from two hours to more than a day to complete.

To address this problem, a number of coal analyzers have been developed. Most of these are ash analyzers and determine the ash content using dual energy transmission or backscatter of X- or  $\gamma$ - rays generated from two or more radioisotopes. A typical prior art system employs a low energy ( $<60$  KeV) and a high energy ( $>600$  KeV)  $\gamma$ - ray source to measure two signals which can

be correlated to ash and density respectively. Watt (U.S. Patent Nos. 4,090,074 and 4,566,114) uses any number of radioisotope sources from a group consisting of Am-241, Gd-153, Cd-109, Ba-133, Cs-137 and Co-57 to generate a series of incident X- and/or  $\gamma$ - ray energies that are transmitted or scattered through a layer of coal. The determination of the ash or mineral matter content in coal uses a transmission or scatter of X- or  $\gamma$ - rays at an energy where there is a significant difference in the absorption of radiation per unit weight in coal and mineral matter excluding iron (low energy ash measurement), in combination with a measurement of the bulk density (high energy). This is predominately the type of ash analyzer in use.

A variation of this ash analyzer was developed by Page as described in U.S. Patent No. 4,486,894. An iron correction factor was incorporated into the ash determination. Low energy (<60 KeV) radiation bombards a sample with the primary radiation comprising at least two spectrums of energies (46 KeV and 9-17 KeV) to cause radiative reactions in the coal and measuring backscattered radiation in the same energy regions along with a fluoresced iron peak at 6.4 KeV. The fluoresced iron peak can also be related to the sulfur content in certain coals. Page (U.S. Patent No. 4,015,124) approximated the sulfur content of a given type of coal using the multiple linear regression:

$$S = a + bX + cY$$

Where,

S = concentration of sulfur in the coal sample;

X = intensity of fluorescent radiation emitted by the sulfur in the sample;

Y = intensity of fluorescent radiation emitted by the iron in the sample; and



a,b, and c are constants.

However, the sulfur peak (X) could not be accurately measured and the relationship breaks down when iron pyrites ( $\text{FeS}_2$ ) are either not found in sufficient concentrations to detect with a proportional counter or cannot be directly related to the total sulfur content.

Prior art use of X- ray fluorescence for elemental analysis, and particularly, sulfur, has been limited by the fact that the characteristic sulfur  $K\alpha$  X- ray emitted has an energy of only 2.31 KeV. Thus, the X- ray is quickly dissipated in coal (within 1 mm) or even air. To complicate the measurement, sulfur typically occurs in concentrations of less than 0.3% in coal. Marshall, in U.S. Patent No. 4,171,485 states that the use of X- ray fluorescence other than for gaseous materials requires either the preparation or vaporization of a sample in an atmosphere which does not confuse the measurement. In either case, a difficult sampling and sample-preparation problem compounds the errors associated with X- ray fluorescence itself.

The better method in current use for determining sulfur content as well as several other elements present in the coal is to directly measure the different secondary, characteristic  $\gamma$ - ray energies emitted by the different elements when coal or mineral ores are bombarded by neutrons. This measurement process, as described by Marshall (see reference above) and Atwell in U.S. Patent No. 4,582,992 is known in the art as prompt gamma ray neutron activation analysis (PGNAA). This technique is based on the fact that almost all elements when bombarded by slow neutrons capture these neutrons at least momentarily and form a compound nucleus in an excited state. Usually the prompt emission of one or more  $\gamma$ - rays with energies and intensities that are uniquely characteristic of the captured nucleus dissipates most of the excitation energy. Because these prompt  $\gamma$ - rays often have energies in the 2 to 11 MeV range, they can penetrate substantial

quantities of material to reach a  $\gamma$ - ray detector, i.e., NaI(Tl) scintillation detector.

However, because of the high energies necessary to obtain sufficient penetration of flowing coal streams containing particles with top sizes of 2-4 inches, this technique is costly since neutron emitters and the necessary shielding is involved. X- ray fluorescence provides a safer and less expensive alternative if the sample presentation and X- ray detection problems can be solved.

The present invention addresses both sampling and X-ray detection in the design of a system that will mount directly on a sampling system using a thermoelectrically cooled Si-PIN photodiode X- ray detector.

Detectors used in X- ray spectroscopy in prior art systems for measuring the composition of coal and mineral ores, have been gas filled proportional counters, typically using a low density fill gas such as Neon or Xenon mixed with Argon. The resolution of 600 eV (FWHM) for proportional counters at low X- ray energies (less than Fe at 6.4 KeV) does not enable accurate determination of elements such as sulfur, silica or aluminum. By contrast, a Si-PIN detector has a resolution of 196 eV (FWHM) for a  $^{55}\text{Fe}$  X- ray at 5.9 KeV. Other silicon or semiconductor detectors e.g., Si(Li) can achieve similar high resolutions, but require enclosure in a vacuum cryostat and liquid nitrogen cooling. This seriously limits the applications in which the system can be used. The system must be compact and robust so the detector can be located within 2 inches of the sample surface.

As defined herein, an online sampling means refers to a sampling means wherein the sample is nonstationary relative to the analyzer. For example, in one embodiment of the present invention, the analyzer remains in a fixed, stationary position adjacent to a moving sample stream. In another embodiment, the sample remains fixed, and the analyzer is scanned across the

sample.

By mounting the XRF elemental analyzer in close proximity to a moving stream of fine coal or ore, it is possible to obtain direct measurements of characteristic  $K\alpha$  and in some cases,  $K\beta$ , X- rays for many of the elements in the Periodic Table between aluminum and silver. In measuring coal composition, X- ray peaks for aluminum, silica, sulfur, chlorine, potassium, calcium, titanium and iron can be obtained. An ash measurement can also be obtained as a function of the major elements in the ash and/or a backscattered ash peak. A microwave transmitter/receiver assembly is used to relate microwave attenuation or phase shift to moisture content.

Computer control of the sample size and frequency synchronized with the X- ray detection system enables each sample increment to be analyzed and combined so that a statistically valid sample can be obtained in accordance with ASTM and/or ISO sampling practice. As with any sampling device, the XRF elemental analyzer analyzes a portion of a sample stream assumed to be (1) homogeneous and (2) representative of the lot.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram showing how the XRF Elemental analyzer can be integrated with a mechanical sampling system in a sub-stream configuration.

FIG. 2 is a pictorial view of the analyzer mounted on a sampling system with a layer of coal or ore transported through the analyzer interrogation zone. A plow is used to uniformly shape the surface of the sampled material. The physical layout of the major components including the signal processing elements are shown.

FIG. 2A is an enlarged view of the electronics enclosure and shows a first configuration

of the X- ray generators such that the X- ray source transmission axis and the detection axis are parallel to each other and normal (oriented at 90 degrees) to the sample surface.

FIG. 2B is an enlarged view of the electronics enclosure and shows a second configuration of the X- ray generators such that the X- ray source transmission axis and the detection axis of the detector are oriented generally perpendicular to the sample surface and are aligned to within 30 degrees of each other.

FIG. 3 is a pictorial view of an alternate embodiment where the sample to be analyzed is in slurry form and transported through the interrogation zone in a flow cell. A constant head tank is employed to ensure uniform flow and to minimize air entrainment.

FIG. 4 is a typical X- ray fluorescence spectrum from a sample of coal using a  $^{55}\text{Fe}$  excitation source. An  $^{55}\text{Fe}$  excitation source is equivalent to an X- ray generator with a Cu target.

## DETAILED DESCRIPTION OF THE INVENTION

In a preferred embodiment of the present invention, the XRF elemental analyzer 100 is in a sub-stream configuration as shown in FIG. 1, where part of the process stream to be analyzed is diverted by means of a suitable sampling system for presentation to the on-line analyzer 100. If the coal or ore to be analyzed has a top particle size (95% passing) greater than 3/8 inch or 10 mm, then a size reduction stage is necessary to provide a uniform surface to present to the analyzer 100 for interrogation.

FIG. 2 illustrates how the XRF elemental analyzer system 100 is configured when mounted on a mechanical sampling means. A coal or ore sample, typically the primary save (after crushing) or the secondary reject, is conveyed 40 past the analyzer 100. A plow 50 is used to shape the layer or bed of material to be interrogated. If a moisture determination is to be made,

a microwave transmitter 64/receiver 62 assembly is mounted above and below the conveyor belt 40 to determine moisture as a function of microwave signal attenuation. The moisture meter also can serve as a sensor to determine the presence of material on the conveyor belt 40. If the microwave signal goes below a threshold limit signaling the presence of material on the conveyor belt 40, the multi-channel analyzer 70 is turned on to acquire counts in as many as 16,000 data channels.

An X- ray tube or generator 20 is employed to bombard the sample with incident radiation in the 3-20 KeV range. Higher energies can be used, but the efficiency of excitation for elements below iron (atomic number 26) in the Periodic Table drops when higher energies are used. An X- ray generator 20 is a pyroelectric crystal that generates energetic electrons which produce X- rays in a target material, i.e., copper or molybdenum. A radioisotope or an X- ray tube can also be used, but is not preferred.

A silicon detector 10 is used to measure the resulting fluorescent radiation. The preferred embodiment uses a thermoelectrically cooled Si-PIN photodiode as an X- ray detector. More than one detector 10 may be used if more than one measuring path is necessary to represent the entire sample. Other types of silicon detectors and cooling systems may be applied.

As defined herein, a backscattering geometry is one in which the source 20 and the detector 10 are disposed generally on the same side of the sample. In contrast, a transmission geometry is one in which the source 20 and the detector 10 are on opposite sides of the sample. In the present invention, a backscattering geometry is preferred for the analysis of solid samples. For liquid samples, a transmission geometry may also be used.

The detector(s) 10 and generator(s) 20 are mounted within 2 inches of the surface of the sample. They are protected by a thin window 30 (0.002-0.01 inches) which maintains a sealed

environment for the electronics. To minimize attenuation of the low energy X- rays by the window 30, low atomic density materials such as polypropylene or polyethylene is used. The film may be coated with a resin or acrylic to increase durability.

The detector 10 and generator 20 are mounted within a 90 degree angle of each other with as small of an angle between them as possible. As defined herein, the transmission axis of the X- ray source 20 is the axis along which X- ray emission reaches a maximum. The detection axis of the X- ray fluorescence detector 20 is defined as the surface normal of the X- ray fluorescence sensing element of the detector 20. In a preferred embodiment, the X- ray source transmission axis and the detection axis of the detector 20 are oriented generally perpendicular to the sample surface and are aligned to within 30 degrees of each other (FIG. 2B). In a particularly preferred embodiment, the X- ray source transmission axis and the detection axis are parallel to each other and normal (oriented at 90 degrees) to the sample surface (FIG. 2A). In a most preferred embodiment, one or more X- ray generators 20 are placed concentrically around a detector 10 and all of the above are perpendicular to the surface of the sample.

An alternate configuration in which the detector 10 and generator 20 are mounted on the underside of a chute is also possible.

FIG. 3 depicts another embodiment of the XRF elemental analyzer 200 for slurries. In this case, a sample of the flow stream is obtained from a sample cutter inserted into a pipe. A computer actuated valve 84 controls the flow of the slurry sample to the analyzer 200. Samples from around a processing plant can be sequenced to the analyzer 200 in this manner.

A constant head tank 80 ensures a fixed flow rate through the flow cell 82 containing the X- ray detector(s) 210 and generators(s) 220. It also serves as a de-aerator for slurries containing forth or entrained air.

The flow cell 82 holds the detector 210 and generator 220 in the same configuration as described above. Windows are used to seal the electronics in a water tight chamber. This would include a second X- ray source 220 or a separate density gauge used to measure solids concentration by correlating slurry density (% solids) to attenuation of X- rays or  $\gamma$ - rays. This is done with an incident energy of 20 KeV or higher to minimize the effects of mineralogical composition on the measurement.

In any of the embodiments described, a preamplifier forwards the signal to a shaping amplifier 272 which is connected to the input of a multi-channel analyzer 270 (MCA). The output from the MCA 270 is processed by a computer or programmable logic controller 274 (PLC) to compute the concentrations of various elements in the sample.

FIG. 4 provides an example of the output from the MCA 70, 270 representing an elemental analysis of a western U.S. coal. The areas under each peak correlate to the concentration of each element. These are calibrated using a linear, or sometimes a multiple linear regression (if more than one element occurs together in a certain mineralization) with a laboratory elemental analysis of the sample in accordance with ASTM or ISO procedures. Linear calibration equations are possible to low concentrations of even the lightest elements in the range (e.g. sulfur down to concentrations of 0.5% by weight in ash or 0.05% by weight in coal) because the high peak resolution enables the peak to be distinguished from background and proportionality maintained.

In the case of coal analysis, the ash content can be computed as a function of the major elements in the ash and/or a backscattered peak produced by Compton and Raleigh scattering of the incident beam of radiation. The iron content as measured by the fluoresced Fe  $K\alpha$  X- rays is used as a term in the equation to correct for fluctuations in iron which disproportionately affects

the ash computation.

The apparatus described above directly measures the elemental composition of coal and mineral ores using energy dispersive X- ray fluorescence spectroscopy. It provides an accurate ash measurement by improving upon established methods with the use of iron compensation and

5 can resolve a sulfur peak down to 0.5% weight in ash.

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We claim:

1. An apparatus for online elemental analysis of a sample comprising
  - an online sampling means for receiving a sample,
  - at least one X- ray source, and
  - at least one X- ray fluorescence detector for detecting X- ray fluorescence from said sample and for producing signals in response to said X- ray fluorescence,
  - wherein said at least one X- ray source and said at least one X- ray fluorescence detector are mounted in a geometry that maximizes X- ray detection and sensitivity.
2. The apparatus of claim 1 wherein said at least one X- ray fluorescence detector is mounted within 2 inches of said sample.
3. The apparatus of claim 1 wherein said at least one X- ray source is characterized by a transmission axis and wherein said at least one X- ray fluorescence detector is characterized by a detection axis, and wherein said transmission axis and said detection axis are aligned to within 30 degrees of the sample surface normal.
4. The apparatus of claim 3 wherein said X- ray transmission axis and said detection axis are parallel to each other and normal to the sample surface.
5. The apparatus of claim 1 wherein said at least one X- ray source and said at least one X- ray fluorescence detector are disposed in a backscattering geometry.

6. The apparatus of claim 1 further comprising a thin window (0.002-0.010 inches) disposed between the sample and the X- ray detector.

5 7. The apparatus of claim 6 wherein said thin window is comprised of a polymeric core coated with a resin or acrylic.

8. The apparatus of claim 1 wherein further comprising a shaping device for maintaining a uniform sample surface.

10 9. The apparatus of claim 8 wherein said shaping device comprises a plow or a flow cell.

10. The apparatus of claim 8 further comprising a means for controlling said sampling means to provide a uniform sample profile.

15 11. The apparatus of claim 1 further comprising a means for detecting the presence of sufficient sample material.

20 12. The apparatus of claim 11 wherein said means for detecting the presence of sufficient sample material comprises a microwave, X-ray or  $\gamma$ - ray sensor oriented in a transmission geometry.

13. The apparatus of claim 1 further comprising a microwave moisture reader.

14. The apparatus of claim 1 further comprising a belt scale or density gauge.

15. The apparatus of claim 1 further comprising a flowmeter assembly.

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**ABSTRACT**

An apparatus for measuring the composition of coal and mineral ores on-line, by bombarding a sample stream with low energy X- rays and measuring the characteristic X- rays fluoresced. The assembly is comprised of one or more X- ray generators mounted in a specific geometry with one or more silicon detectors. A representative sample of a flow stream is obtained from a sampling system. Sample presentation to the analyzer is done with a plow or a flow cell to obtain a uniform interrogation zone for the analyzer. Elemental analysis (Aluminum through Silver on the Periodic Table) of the sample is computed from calibration curves generated from a linear relationship with count rates under each peak. Coal ash is determined from a  $f$ (major elements in ash measured, backscattering of incident radiation). Moisture is determined from measuring the attenuation of a microwave beam transmitted through the sample.

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PROCESS STREAM

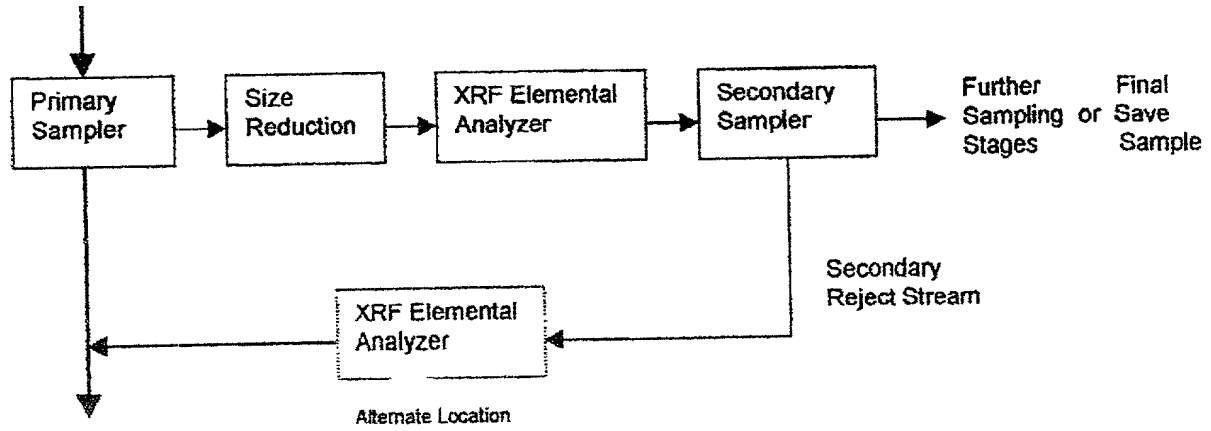


Fig.1

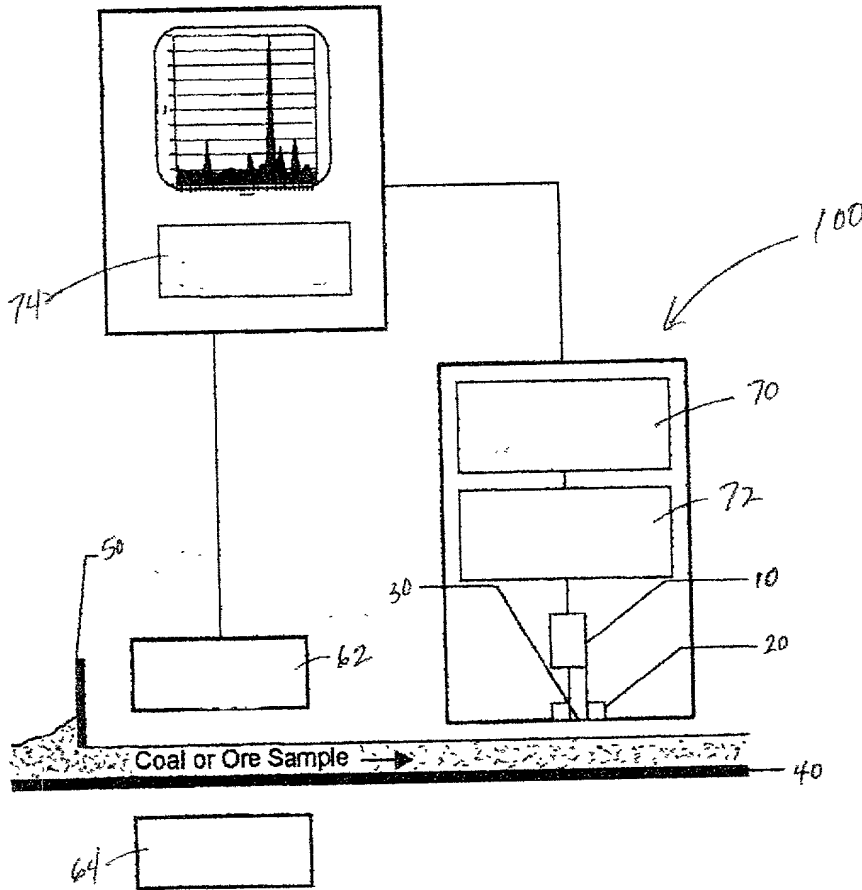


Fig. 2

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FIG 2A

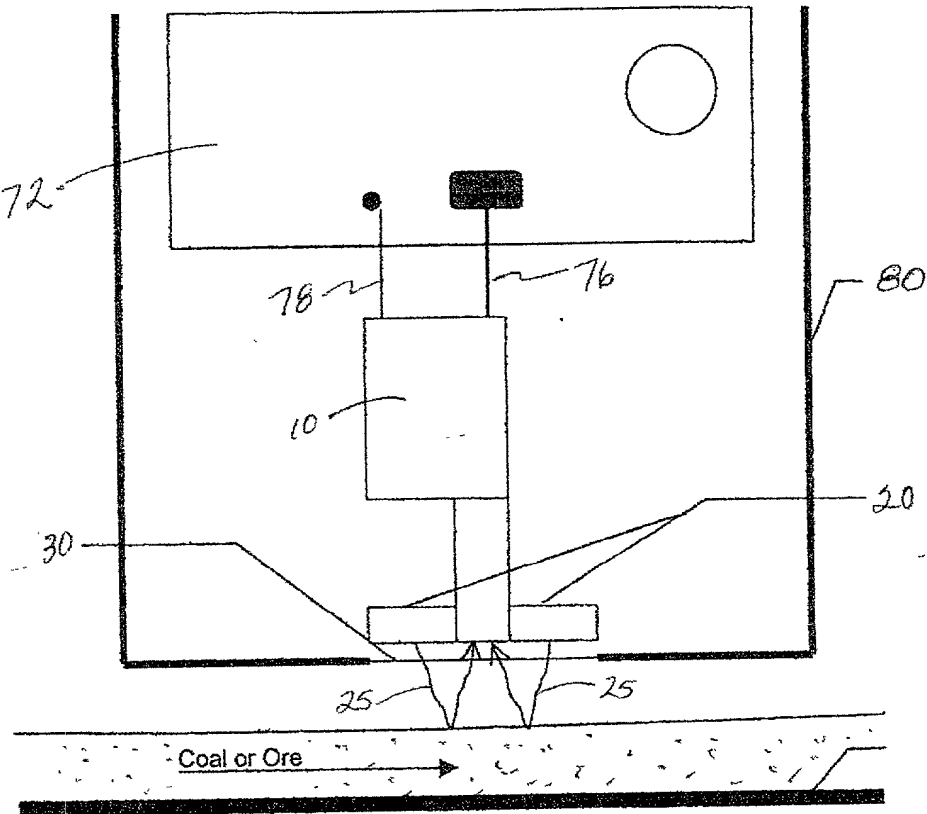
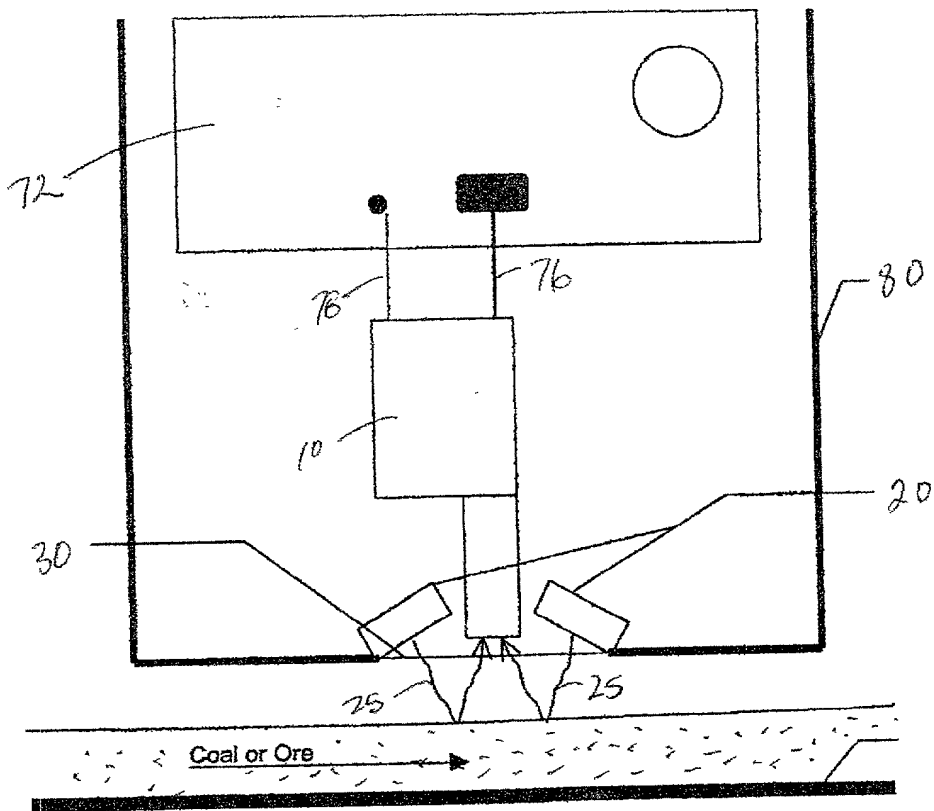


FIG 2B



862T60-82095T60

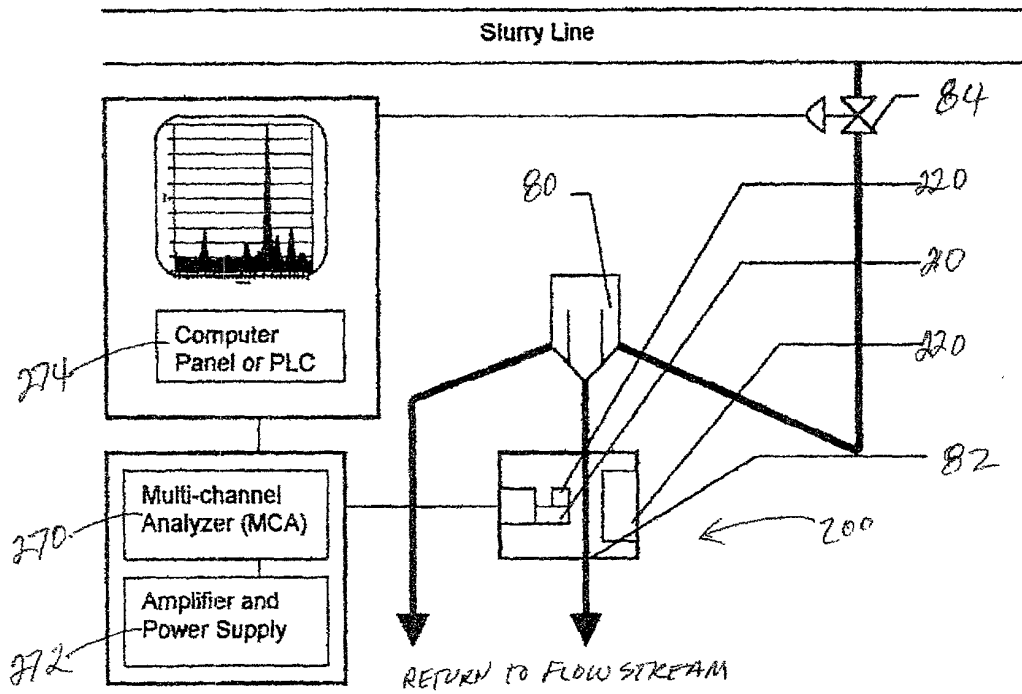


Fig. 3

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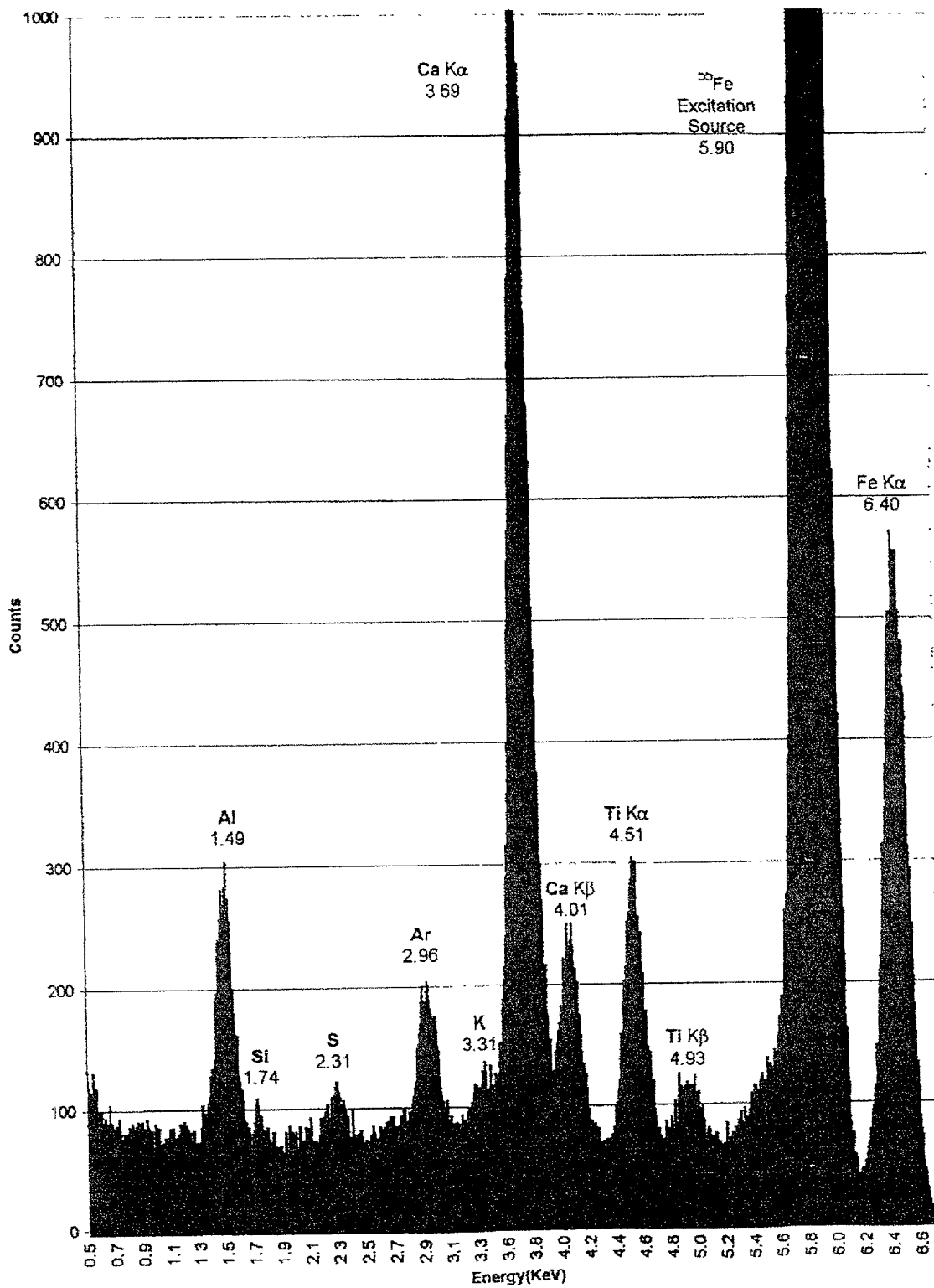


Fig. 4



Practitioner's Docket No. 98208

**PATENT**

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**COMBINED DECLARATION AND POWER OF ATTORNEY**

(ORIGINAL, DESIGN, NATIONAL STAGE OF PCT, SUPPLEMENTAL, DIVISIONAL,  
CONTINUATION OR C-I-P)

---

As a below named inventor, I hereby declare that:

**TYPE OF DECLARATION**

This declaration is of the following type:

*(check one applicable item below)*

- ☒ original.
- ☐ design.
- ☐ supplemental.

*NOTE: If the declaration is for an International Application being filed as a divisional, continuation or continuation-in-part application, do not check next item; check appropriate one of last three items.*

- ☐ national stage of PCT.

*NOTE: If one of the following 3 items apply, then complete and also attach ADDED PAGES FOR DIVISIONAL, CONTINUATION OR C-I-P.*

- ☐ divisional.
- ☐ continuation.
- ☐ continuation-in-part (C-I-P).

**INVENTORSHIP IDENTIFICATION**

**WARNING:** *If the inventors are each not the inventors of all the claims, an explanation of the facts, including the ownership of all the claims at the time the last claimed invention was made, should be submitted.*

My residence, post office address and citizenship are as stated below, next to my name. I believe that I am the original, first and sole inventor (*if only one name is listed below*) or an original, first and joint inventor (*if plural names are listed below*) of the subject matter that is claimed, and for which a patent is sought on the invention entitled:

**TITLE OF INVENTION**

X-RAY FLUORESCENCE ELEMENTAL ANALYZER

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## SPECIFICATION IDENTIFICATION

the specification of which:

(complete (a), (b) or (c))

(a) ☒ is attached hereto.

NOTE: "The following combinations of information supplied in an oath or declaration filed on the application filing date with a specification are acceptable as minimums for identifying a specification and compliance with any one of the items below will be accepted as complying with the identification requirement of 37 CFR 1.63:

"(1) name of inventor(s), and reference to an attached specification which is both attached to the oath or declaration at the time of execution and submitted with the oath or declaration on filing;

"(2) name of inventor(s), and attorney docket number which was on the specification as filed;  
or

"(3) name of inventor(s), and title which was on the specification as filed."

Notice of July 13, 1995 (1177 O.G. 60).

(b) ☐ was filed on \_\_\_\_\_, as ☐ Serial No. 0 / \_\_\_\_\_  
or ☐ \_\_\_\_\_  
and was amended on \_\_\_\_\_ (if applicable).

NOTE: Amendments filed after the original papers are deposited with the PTO that contain new matter are not accorded a filing date by being referred to in the declaration. Accordingly, the amendments involved are those filed with the application papers or, in the case of a supplemental declaration, are those amendments claiming matter not encompassed in the original statement of invention or claims. See 37 CFR 1.67.

NOTE: "The following combinations of information supplied in an oath or declaration filed after the filing date are acceptable as minimums for identifying a specification and compliance with any one of the items below will be accepted as complying with the identification requirement of 37 CFR 1.63:

"(1) name of inventor(s), and application number (consisting of the series code and the serial number; e.g., 08/123,456);

"(2) name of inventor(s), serial number and filing date;

"(3) name of inventor(s) and attorney docket number which was on the specification as filed;

"(4) name of inventor(s), title which was on the specification as filed and filing date;

"(5) name of inventor(s), title which was on the specification as filed and reference to an attached specification which is both attached to the oath or declaration at the time of execution and submitted with the oath or declaration; or

"(6) name of inventor(s), title which was on the specification as filed and accompanied by a cover letter accurately identifying the application for which it was intended by either the application number (consisting of the series code and the serial number; e.g., 08/123,456), or serial number and filing date. Absent any statement(s) to the contrary, it will be presumed that the application filed in the PTO is the application which the inventor(s) executed by signing the oath or declaration."

Notice of July 13, 1995 (1177 O.G. 60).

(c) ☐ was described and claimed in PCT International Application No. \_\_\_\_\_, filed on \_\_\_\_\_ and as amended under PCT Article 19 on \_\_\_\_\_ (if any).

## ACKNOWLEDGEMENT OF REVIEW OF PAPERS AND DUTY OF CANDOR

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information, which is material to patentability as defined in 37, Code of Federal Regulations, § 1.56,

*(also check the following items, if desired)*

- ☒ and which is material to the examination of this application, namely, information where there is a substantial likelihood that a reasonable Examiner would consider it important in deciding whether to allow the application to issue as a patent, and
- ☒ in compliance with this duty, there is attached an information disclosure statement, in accordance with 37 CFR 1.98.

### PRIORITY CLAIM (35 U.S.C. § 119(a)-(d))

I hereby claim foreign priority benefits under Title 35, United States Code, §§ 119(a)-(d) of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed.

*(complete (d) or (e))*

- (d) ☒ no such applications have been filed.
- (e) ☐ such applications have been filed as follows.

NOTE: Where item (c) is entered above and the International Application which designated the U.S. itself claimed priority check item (e), enter the details below and make the priority claim.

**PRIOR FOREIGN/PCT APPLICATION(S) FILED WITHIN 12 MONTHS  
(6 MONTHS FOR DESIGN) PRIOR TO THIS APPLICATION  
AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. § 119(a)-(d)**

COUNTRY (OR INDICATE IF PCT)	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 37 USC 119
			<input type="checkbox"/> YES    NO <input type="checkbox"/>
			<input type="checkbox"/> YES    NO <input type="checkbox"/>
			<input type="checkbox"/> YES    NO <input type="checkbox"/>
			<input type="checkbox"/> YES    NO <input type="checkbox"/>
			<input type="checkbox"/> YES    NO <input type="checkbox"/>

**CLAIM FOR BENEFIT OF PRIOR U.S. PROVISIONAL APPLICATION(S)**  
(34 U.S.C. § 119(e))

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below:

PROVISIONAL APPLICATION NUMBER

FILING DATE

\_\_\_\_\_/\_\_\_\_\_  
\_\_\_\_\_/\_\_\_\_\_  
\_\_\_\_\_/\_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**CLAIM FOR BENEFIT OF EARLIER US/PCT APPLICATION(S)**  
**UNDER 35 U.S.C. 120**

- ☐ The claim for the benefit of any such applications are set forth in the attached ADDED PAGES TO COMBINED DECLARATION AND POWER OF ATTORNEY FOR DIVISIONAL, CONTINUATION OR CONTINUATION-IN PART (C-I-P) APPLICATION.

**ALL FOREIGN APPLICATION(S), IF ANY, FILED MORE THAN 12 MONTHS  
(6 MONTHS FOR DESIGN) PRIOR TO THIS U.S. APPLICATION**

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NOTE: If the application filed more than 12 months from the filing date of this application is a PCT filing forming the basis for this application entering the United States as (1) the national stage, or (2) a continuation, divisional, or continuation-in-part, then also complete ADDED PAGES TO COMBINED DECLARATION AND POWER OF ATTORNEY FOR DIVISIONAL, CONTINUATION OR C-I-P APPLICATION for benefit of the prior U.S. or PCT application(s) under 35 U.S.C. § 120.

**POWER OF ATTORNEY**

I hereby appoint the following practitioner(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

*(list name and registration number)*

Charles F. Meroni, Jr.  
Reg. No. 20,109

*(check the following item, if applicable)*

- ☐ I hereby appoint the practitioner(s) associated with the Customer Number provided below to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.
- ☐ Attached, as part of this declaration and power of attorney, is the authorization of the above-named practitioner(s) to accept and follow instructions from my representative(s).

SEND CORRESPONDENCE TO

DIRECT TELEPHONE CALLS TO:  
*(Name and telephone number)*

☒ Address

Charles F. Meroni, Jr.  
Meroni & Meroni  
A Professional Corporation  
P.O. Box 309  
Barrington, IL 60011

Charles F. Meroni, Jr.  
(847) 304-1500  
(847) 382-5478 (Fax)

☐ Customer Number \_\_\_\_\_

## DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

## SIGNATURE(S)

NOTE: Carefully indicate the family (or last) name, as it should appear on the filing receipt and all other documents.

Full name of sole or first inventor

Melvin J. Laurila  
(GIVEN NAME) (MIDDLE INITIAL OR NAME) FAMILY (OR LAST NAME)  
Inventor's signature *Melvin J. Laurila*  
Date 9/17/98 Country of Citizenship United States  
Residence 24674 W. August Lane, Lake Zurich, IL 60047  
Post Office Address 24674 W. August Lane, Lake Zurich, IL 60047

Full name of second joint inventor, if any

Claus C Bachmann  
(GIVEN NAME) (MIDDLE INITIAL OR NAME) FAMILY (OR LAST NAME)  
Inventor's signature \_\_\_\_\_  
Date \_\_\_\_\_ Country of Citizenship Germany  
Residence 41 Silcherst, D-75323 Bad Wilbad, Germany  
Post Office Address 41 Silchertst, D-75323 Bad Wilbad, Germany

Full name of third joint inventor, if any

Albert P. Klein  
(GIVEN NAME) (MIDDLE INITIAL OR NAME) FAMILY (OR LAST NAME)  
Inventor's signature \_\_\_\_\_  
Date \_\_\_\_\_ Country of Citizenship Germany  
Residence 8 Ahornweg, D-72226 Simmersfeld, Germany  
Post Office Address 8 Ahornweg, D-72226, Simmersfeld, Germany

### DECLARATION

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

### SIGNATURE(S)

NOTE: Carefully indicate the family (or last) name, as it should appear on the filing receipt and all other documents.

Full name of sole or first inventor

Melvin J. Laurila  
(GIVEN NAME) (MIDDLE INITIAL OR NAME) FAMILY (OR LAST NAME)

Inventor's signature

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Post Office Address 24674 W. August Lane, Lake Zurich, IL 60047

Full name of second joint inventor, if any

Claus C Bachmann  
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Residence 41 Silcherst, D-75323 Bad Wildbad, Germany

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Full name of third joint inventor, if any

Albert P. Klein  
(GIVEN NAME) (MIDDLE INITIAL OR NAME) FAMILY (OR LAST NAME)

Inventor's signature

Date \_\_\_\_\_ Country of Citizenship Germany

Residence 8 Ahornweg, D-72226 Simmersfeld, Germany

Post Office Address 8 Ahornweg, D-72226, Simmersfeld, Germany

(Declaration and Power of Attorney [1-1]—page 6 of 7)

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09156078-091798

(check proper box(es) for any of the following added page(s)  
that form a part of this declaration)

- ☐ **Signature** for fourth and subsequent joint inventors. *Number of pages added* \_\_\_\_\_

\* \* \*

- ☐ **Signature** by administrator(trix), executor(trix) or legal representative for deceased or incapacitated inventor. *Number of pages added* \_\_\_\_\_

\* \* \*

- ☐ **Signature** for inventor who refuses to sign or cannot be reached by person authorized under 37 CFR 1.47. *Number of pages added* \_\_\_\_\_

\* \* \*

- ☐ Added page for **signature** by one joint inventor on behalf of deceased inventor(s) where legal representative cannot be appointed in time. (37 CFR 1.47)

\* \* \*

- ☐ Added pages to combined declaration and power of attorney for divisional, continuation, or continuation-in-part (C-I-P) application.

☐ Number of pages added \_\_\_\_\_

\* \* \*

- ☐ Authorization of practitioner(s) to accept and follow instructions from representative.

\* \* \*

(if no further pages form a part of this Declaration,  
then end this Declaration with this page and check the following item)

- ☒ This declaration ends with this page.